Koocanusa Reservoir Water Quality Monitoring Plan

2018

Teck

1.0 Objectives

Surface water quality data within Koocanusa Reservoir, British Columbia (BC) are being collected to better characterize water quality and understand spatial, and temporal (seasonal and annual) variability. Data collected over time in a consistent manner will allow for trend monitoring in water quality including the effectiveness of Teck's mitigation actions associated with implementation of the Elk Valley Water Quality Plan (EVWQP) and Permit 107517.

Objectives associated with this program include:

1. Monitor overall water quality in Koocanusa Reservoir, BC to meet Permit 107517 sampling requirements at permitted locations. Data is compared to permit limits, BC water quality guidelines, targets established within the EVWQP and reference conditions.

2. Inform management decisions and support other monitoring programs at a regional scale (e.g., Regional Aquatic Effects Monitoring Program [RAEMP], Koocanusa Reservoir Monitoring Program).

In addition to the above-listed objectives, the sampling program considers active monitoring programs conducted outside of the Designated Area (e.g., Montana Department of Environmental Quality), and to the extent possible, ensures that sampling methods and analytical procedures are harmonized to facilitate direct data comparisons.

2.0 Sample Locations, Frequency and Timing

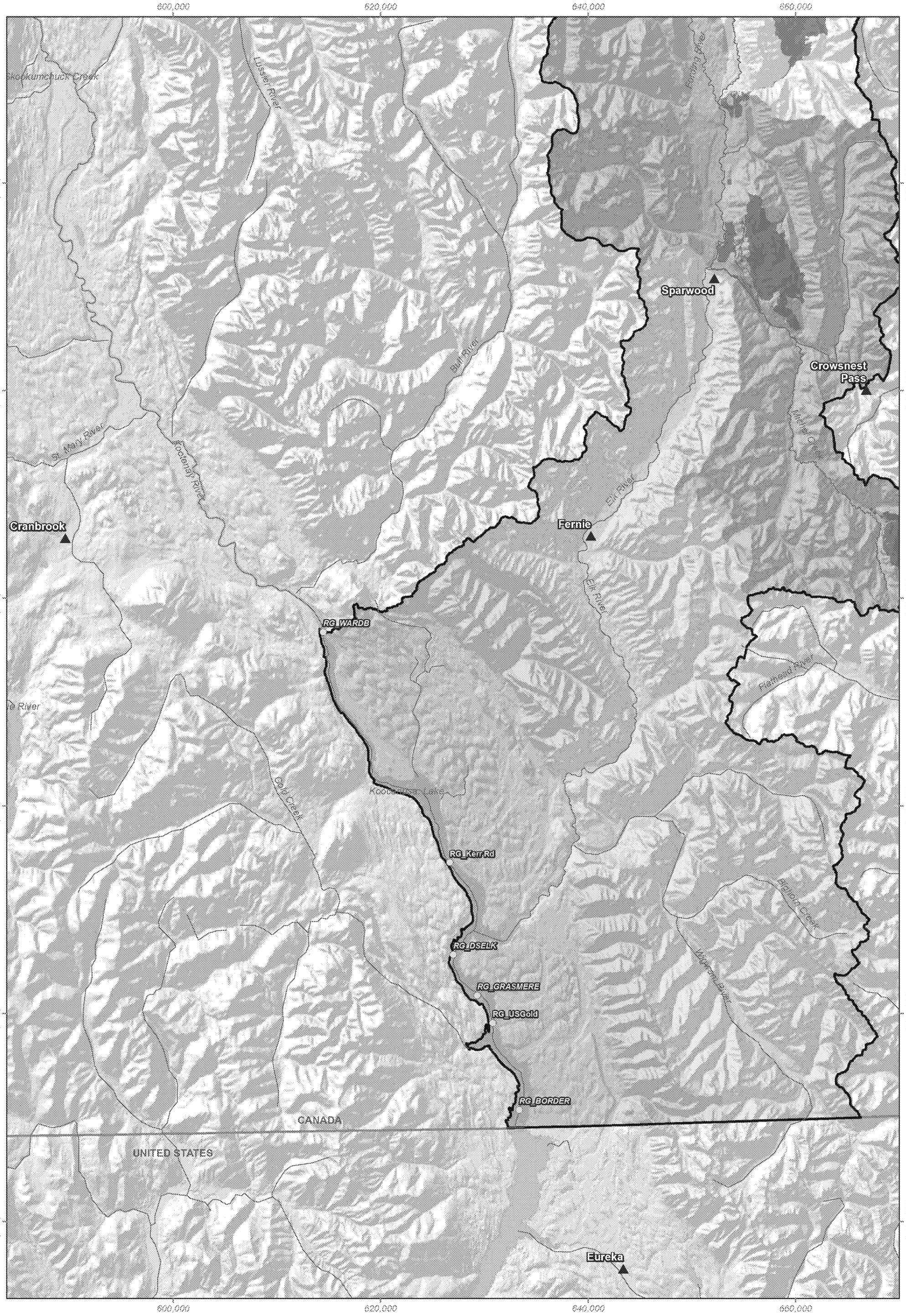
Water levels within the reservoir experience significant annual fluctuations which are controlled by two primary factors: 1) spring inflow volumes via the Kootenay, Bull and Elk Rivers; and 2) annual drawdown (Hardy and Paragamian 2013, Richards 1997, Crozier and Nordin 1983). Management objectives of the reservoir include flood and environmental protection, hydropower, and recreation. Using an area/capacity curve, HydroQual (1990) illustrated that the Canadian portion of the reservoir experiences the greatest relative change in water elevation. For instance, at full pool, water depth at the Canada-US border is approximately 40 meters (m), but during annual drawdown is ≤10 m. Associated variability in conditions was considered in the development of the monitoring program.

The sampling locations for the Koocanusa Reservoir water quality sites are listed in Table 1 and illustrated in Figure 1. The sampling locations contained in Table 1 are, in some cases, approximate locations and some "field fitting" may be required to ensure safe access during sampling (e.g. ice coverage or riverine conditions).

Table 1. Water Quality Monitoring Stations in Koocanusa Reservoir

Station Name / Descriptor	Station Code	EMS #	Universal Transverse Mercator Coordinates	
			Easting	Northing
Koocanusa Reservoir at Wardner	RG_WARDB	N/A	614501	5476717
Koocanusa Reservoir u/s Elk River and d/s of Kikkoman Creek	RG_KERRRD	E300095	626575	5454366
Koocanusa Reservoir d/s Elk River	RG_DSELK	E300230	627055	5445568
Koocanusa Reservoir West of Grasmere	RG_GRASMERE	E300092	629326	5441735
Koocanusa Reservoir u/s Gold Creek	RG_USGOLD	E300093	630811	5439055
Koocanusa Reservoir u/s Canada/US Border	RG_BORDER	E300094	633382	5430699

Water Quality Monitoring Stations in Lake Koocanusa



N

0 2.5 5 10 Kilometers

1:332,000

- Communities
- Water Quality Monitoring Stations
- Rivers
- Teck Coal Mine Operations
- Ministerial Order Boundary

EVWQP MU

- MU-1
- MU-2
- MU-3
- MU-4
- MU-5
- MU-6

Teck

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Sampling frequency will be weekly from April 1st to July 15th and otherwise monthly as field conditions permit. Timing of monthly sampling will, to the extent possible, be consistent with regional surface water sampling efforts conducted by Teck Coal Limited (Teck) operations. It is acknowledged *a priori* that there will be periods of time (e.g., winter) in which safety issues and concerns (e.g., thin ice, and/or ice cover with falling/rapidly fluctuating water levels) may preclude surface water sampling activities on the reservoir. Weekly sampling should be conducted during the ascending limbs of the hydrograph and full pool when the reservoir has the greatest potential to be thermally stratified (May 1 – July 15) (Figure 2). The descending limbs of the hydrograph typically occur during winter months when sampling is limited due to ice, combined with dropping water levels, restricting access on the reservoir.

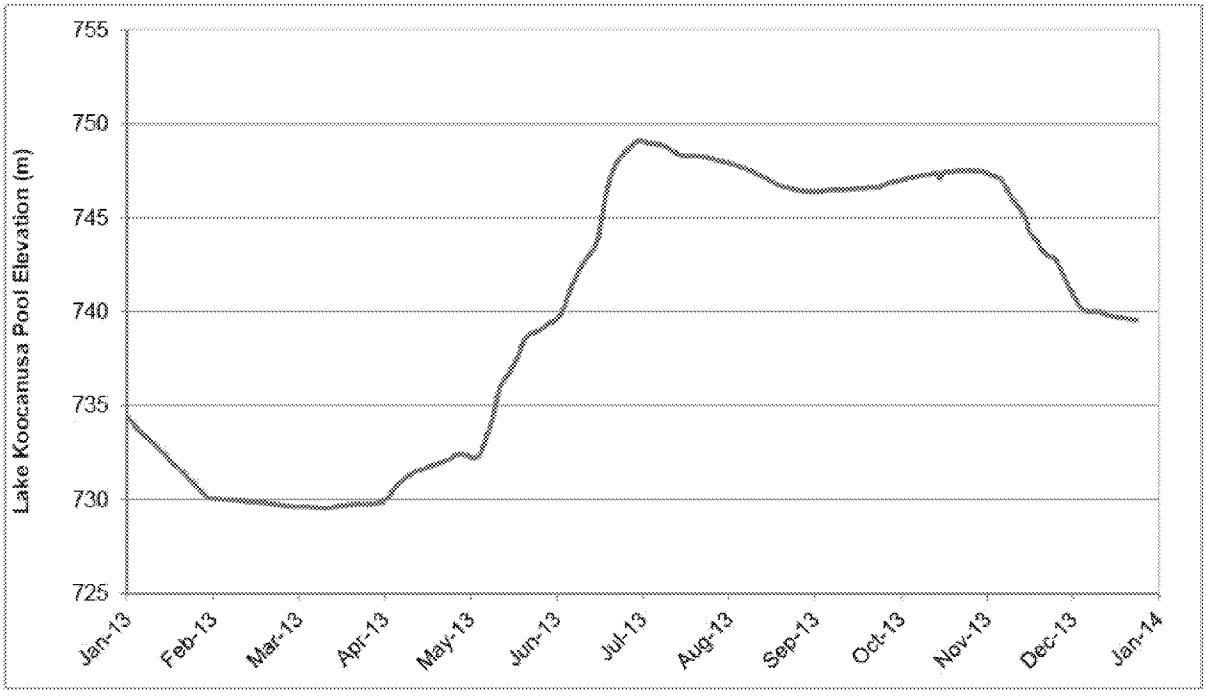

Figure 2: Typical annual elevation fluctuations observed in Koocanusa Reservoir
Data from United States Army Corps of Engineers, 2014

3.0 Reservoir Sampling Methods and Monitoring Parameters

Water sampling activities will be completed in accordance with methods outlined by the 2013 edition of the British Columbia Field Sampling Manual (Clark, M.J.R. (editor). 2003), Teck's field monitoring manual (Exponent, 2012) and consistent with the Montana Department of Environmental Quality "*Lake Koocanusa Sampling Project – 2013: Water Quality Sampling Plan*".

Prior to sampling, the crew will first determine whether or not the water column is stratified by lowering a data logger or multimeter probe set to log depth, and temperature. Stratification into an epilimnion and hypolimnion will be confirmed wherever a thermocline (defined as a 1°C change over 1 meter depth) is recorded. This temperature differential must be sustained in order to constitute stratification. Sampling will be conducted as per the sample decision tree shown in Figure 3. Where stratified, one composite sample will be formed from three evenly spaced grab samples in the epilimnion (samples identified as S1) and one composite sample similarly from the hypolimnion (samples identified as S2). Where unstratified, samples will be collected 3 m from the

surface (samples identified as U1), 3 m from the substrate (samples identified as U3) and at the mid-point of the water column (samples identified as U2). Samples will be collected with a Van Dorn sampler or equivalent depth sampler and labelled as above. Note that in certain conditions when the reservoir level is very low, conditions are essentially riverine. In these conditions it may only be possible to obtain a single sample, collected from the shoreline, at the closest safe location to the permitted sample location. Safety of a location will be assessed with respect to reservoir bank stability, ground consistency (i.e. ice shelves and mud flats), flow characteristics, etc. Efforts will be taken to conduct shore samples matching the permitted sample location's latitude however due to access issues the sampling location may be adjusted downstream to a safe alternative as close to the permitted sampling location as possible.

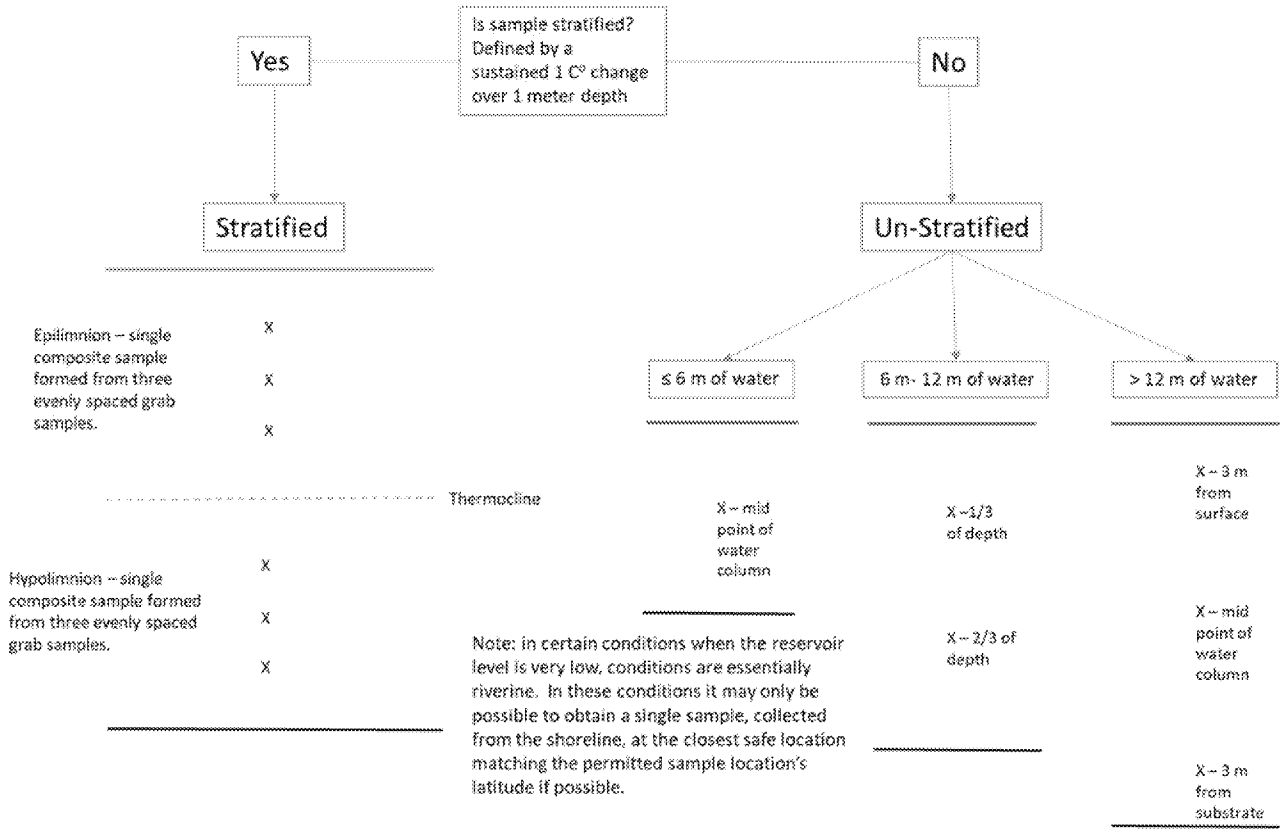

Figure 3: Sampling decision tree for depth integrated sampling in Koocanusa Reservoir

Field Measurements

Upon arrival at a monitoring location (Table 1), general water quality parameters (i.e., water temperature, pH, dissolved oxygen, specific conductivity, and oxidative-reduction potential) will be measured *in situ* at all sampling locations using an YSI 650/6600 multi-probe sensor or equivalent. The meter(s) will be calibrated daily before the start of work. A vertical profile of dissolved oxygen and temperature will be conducted monthly.

A secchi disc depth measurement will also be collected at each monitoring site. The disk will be lowered until it is no longer visible and the depth recorded. The disk is then raised and the depth at which it reappears is recorded. Observations are made on the shaded side of the boat by a person not wearing polarized glasses. During riverine conditions it may only be possible to obtain a single sample, collected from the shoreline, at the closest safe location to matching the permitted sample location. During these conditions a secchi disk measurement may not be feasible due to the depth

and safety of a location. The safety of a location will be assessed with respects to reservoir bank stability, ground consistency (i.e. ice shelves), flow characteristics, etc.

Analytical Measurements

Samples will be collected in sample bottles provided by the laboratory and preserved, as appropriate, for the analyses detailed in Table 25 of the Permit 107517 as show below:

Table 25- Surface Water Monitoring Program: Explanatory Notes

a	**Field Parameters** must include water temperature, specific conductance, dissolved oxygen, pH; for Koocanusa Reservoir locations this includes vertical profiles of dissolved oxygen and temperature
b	**Conventional Parameters** must include specific conductance, total dissolved solids, total suspended solids, hardness, alkalinity, dissolved organic carbon, total organic carbon, turbidity.
c	**Major Ions** must include bromide, fluoride, calcium, chloride, magnesium, potassium, sodium, sulphate.
d	**Nutrients** must include ammonia, nitrate, nitrite, TKN, orthophosphate, total phosphorus.
e	**Dissolved Metals Scan** must include aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc. **Total Metals Scan** must include aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc.

For chlorophyll-a, a fixed volume of sample water is filtered in the field, with the filter supplied to the laboratory in a lab-supplied sample tube.

Analysis will be conducted in accordance with the procedures described in the most recent edition of the British Columbia Laboratory Methods Manual for the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air by third party certified laboratory

4.0 Quality Assurance and Quality Control Requirements

Quality Assurance and Quality Control (QA/QC) procedures for monitoring will consist of calibrating field meters and collecting necessary field QC samples per requirements detailed in Clark (2003), Teck's field monitoring manual (Exponent, 2012) and the BC Field Sampling Manual (2013). Specific QA/QC measures to be followed are presented below.

Field quality control (QC) samples will be used to assess sample variability and evaluate potential sources of contamination. Field QC samples will include field replicates, blanks and equipment rinsate blanks. The following QC samples will be collected in the field and analyzed by the analytical laboratory.

Field Calibration - Field measurements will be collected during each surface water sampling event and at each monitoring location. Meter(s) used to obtain field measurements will be calibrated daily before the start of work. Calibration will be in accordance with procedures and schedules outlined in the particular instrument's operations and maintenance manual. If calibration fails, a second attempt will be made to calibrate the unit. If the second attempt fails, the unit will be replaced with a backup.

Field Replicate Samples (i.e. field duplicate) - Blind field replicate samples will be collected and analyzed to assess the environmental, sample processing, and laboratory variability within a sampling location. Field replicates will be collected in the same manner as the original field sample and will be assigned a unique sample number so that the laboratory will not know it is a QC

sample. Field replicates will be collected at the same water depth and same location as the parent sample and at a minimum frequency of 10 percent of total samples taken.

Field Blank Samples – These should be provided using laboratory supplied de-ionized water and should be exposed to all the same potential sources of contamination as other samples, including handling, filtration and preservation. Field blanks will be prepared at the same location as the "parent" sample and should be provided at a minimum frequency of 1 per sampling event.

Trip (travel) Blanks – These are pre-filled, laboratory prepared samples that are carried through the sample collection event but remain unopened. These will be conducted at a minimum frequency of 1 per sampling event.

Equipment Rinsate Blanks - Equipment rinsate blanks will be collected to help identify possible contamination from the sampling environment or from the sampling equipment (e.g., Van Dorn sampler). One equipment rinsate blank will be generated for each sampling event. Equipment rinsate blanks will consist of running distilled/deionized water through the sampling equipment after decontamination.

5.0 Sample Handling and Records

Sample coolers and packing materials will be supplied by the analytical laboratory. Samples will be packed in a cooler with each set of sample bottle place into a large plastic bag. Glass jars (if used) will be packed to prevent breakage and separated in the cooler by bubble wrap or other shock-absorbent material. Ice in sealed plastic bags or ice packs will be placed in the cooler to maintain a temperature of approximately 4°C (±2°C). When the cooler is full the chain-of-custody (COC) form will be placed into a zip-locked bag and placed in the cooler.

Field data collection forms, digital photos, and COC's will be appropriately documented and stored per Teck's field monitoring manual (Exponent, 2012). Laboratory results will be provided to Teck in Electronic Data Deliverable format consistent with Teck's EQuIS database management procedures. Field Results will be provided to Teck in Electronic Data Deliverable format consistent with Teck's Regional sampling nomenclature guide. Data will be uploaded by Teck to the ENV Environmental Monitoring System database as per Teck's BC ENV EMS Upload Report - User Guide.

6.0 Data Analysis

Data collected under this plan will be reported on as part of Teck's Permit 107517 quarterly and annual water quality reports. This data will also be analyzed and reported on within the Regional Aquatic Effects Monitoring Program and Koocanusa Reservoir Monitoring Program.

7.0 Safety and Limiting Factors

There are several safety concerns and limiting factors that could affect the sampling program. Sampling teams need to be aware of weather conditions, including potential sudden changes in weather, ice, floating and submerged debris. Personal floatation devices (PFDs) are mandatory for all members of field crews while working on or adjacent to water. Sampling teams must have a minimum of two people who work within sight/sound of one another to avoid any inherent risks of working alone. If conditions are deemed unsafe by the sampling team, the attempt to collect the

sample will be documented and sampling will be delayed until such time that conditions are determined safe. Results of the sampling events or attempts of the events will be summarized in the Permit 107517 quarterly reports.

8.0 Linkage with Regional Aquatic Effects Monitoring Program

All data and evaluation completed as part of this water quality sampling plan will be used to inform and evaluate chemical conditions within the reservoir completed as part of the ongoing Koocanusa Reservoir Monitoring Program. Future updates to the study design for Koocanusa Reservoir will incorporate both the biological and the water quality sampling plan. The Koocanusa Reservoir Monitoring Program has been developed as a supporting study to the RAEMP study design based on differences in aquatic habitat, receptors, and stressors (e.g., management of water levels in the reservoir), but results from the former will be incorporated in the RAEMP reporting as per Permit 107517 requirements.

9.0 References

Clark, M.J.R. (editor). 2003. British Columbia Field Sampling Manual. Water, Air and Climate Change Branch, Ministry of Water, Land and Air Protection, Victoria, BC, Canada. 312 pp.

Crozier, R.J. and R.N. Nordin. 1983. The Canadian Portion of Koocanusa Reservoir: Post Impoundment Water Quality 1972-1978. Province of British Columbia, Ministry of Environment. Cranbrook, British Columbia. October.

Exponent, Inc. (Exponent). 2012. Field Monitoring Manual as prepared for Teck Coal Limited. Sparwood, BC.

Hardy, R. and V.L. Paragamian. 2013. A synthesis of Kootenai River burbot stock history and future management goals. Transaction of the American Fisheries Society 142:1662-1670.

HydroQual Canada Limited (HydroQual). 1990. Koocanusa Reservoir State of the Aquatic Environment 1972-1988. Prepared for Waste management Branch, B.C. Ministry of Environment, Cranbrook, British Columbia. March.

Richards, D. 1997. Kootenai River Biological Baseline Status Report. Prepared for the U. S. Department of Energy; Bonneville Power Administration, Environment, Fish and Wildlife. Project Number 94-49 Contract Number 95BI40364. Bonners Ferry, ID. February.